

Exploring the Impact of the Christchurch, New Zealand Earthquake on Landscape Trees

A presentation by

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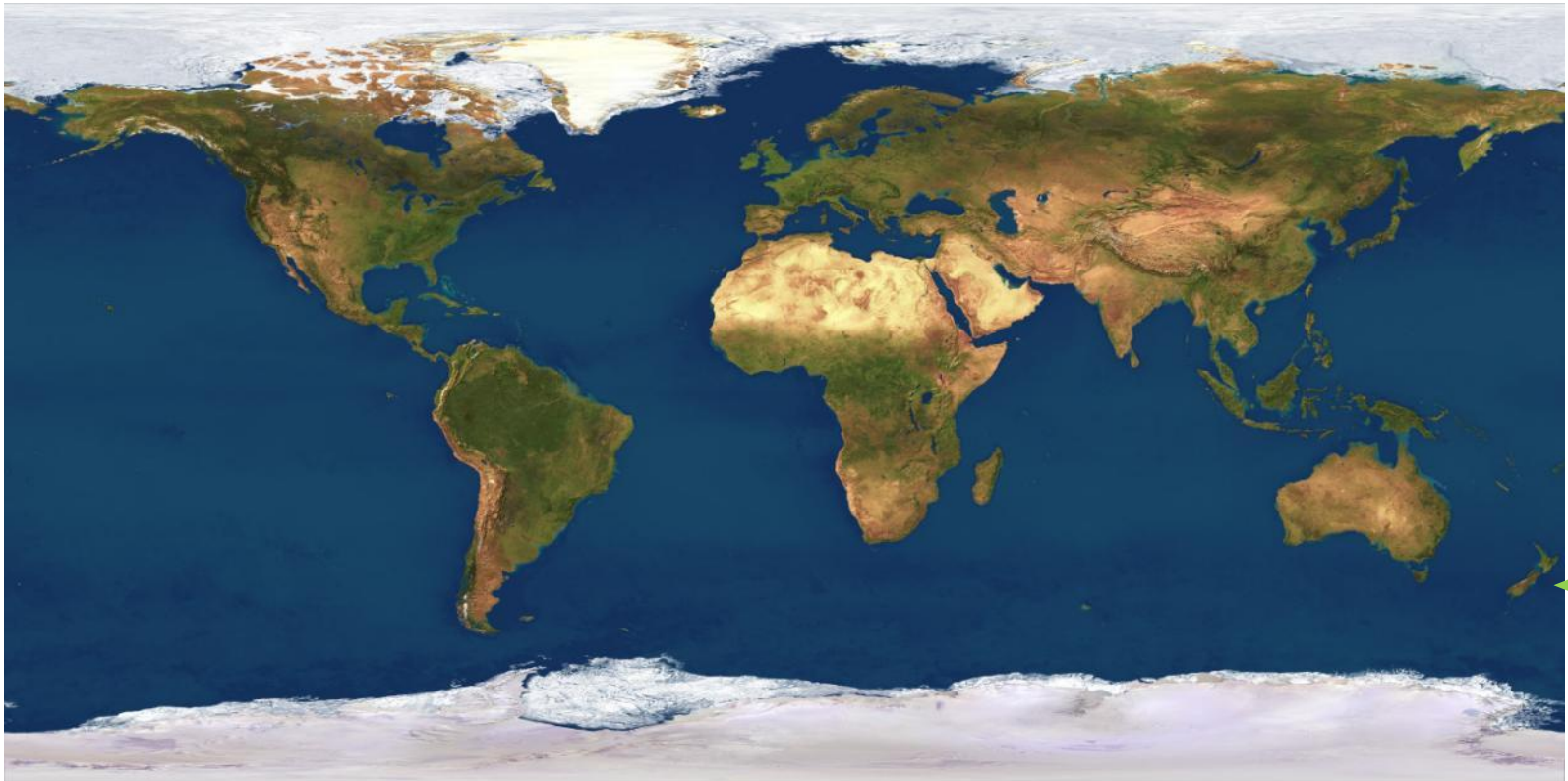
Earthquake!



Research Questions

1. What was the effect of the Christchurch earthquakes on city trees?
2. How do we manage tree removals?
3. What role was played by trees and greenspaces in Christchurch's resilience?

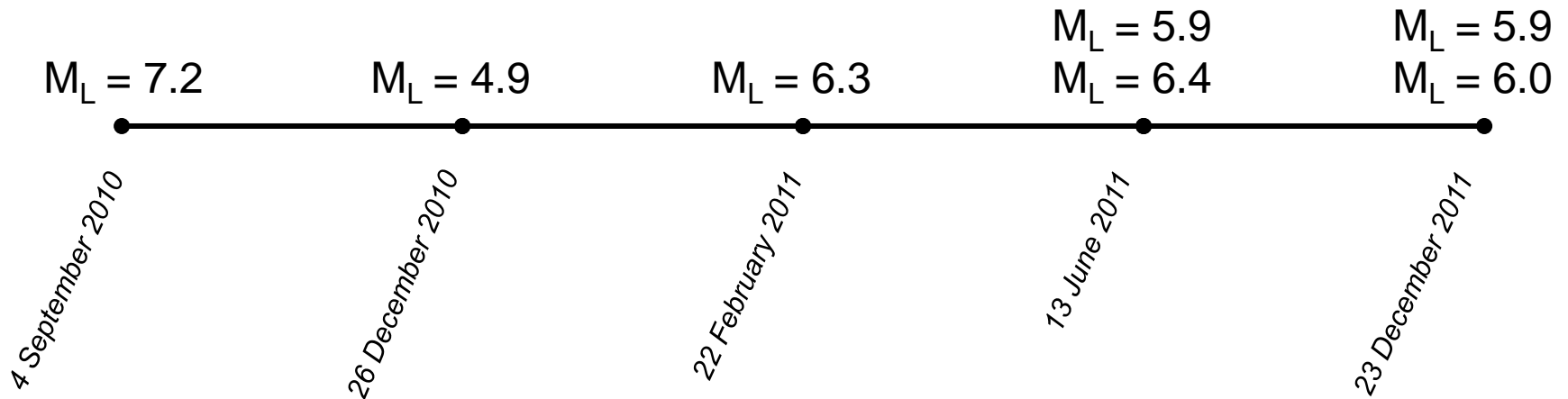
Christchurch, New Zealand



Christchurch, New Zealand



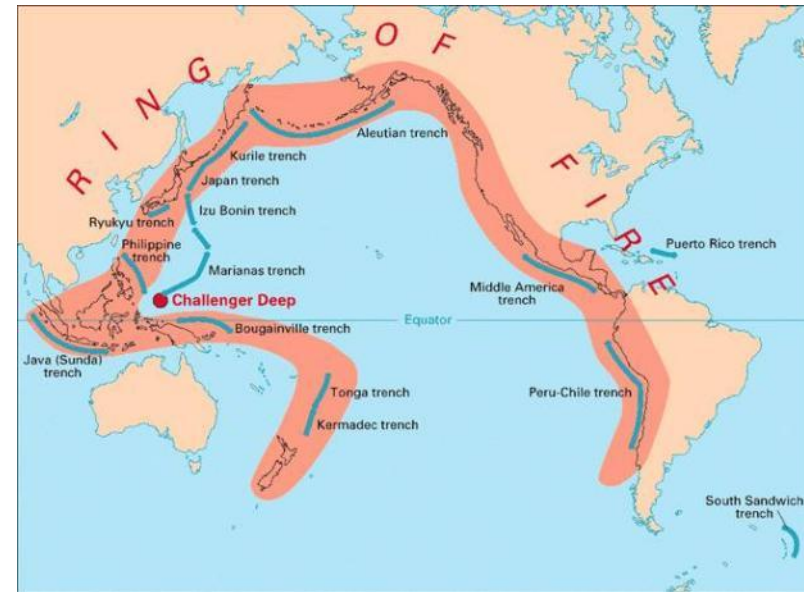
Earthquake Timeline



- ~ 9,000 aftershocks since 4 September 2010
 - Over 20 per day

The 22 February 2011 6.3 M_w EQ

- Earthquakes are common in NZ
- Record ground accelerations of 2.2 g
- 185 confirmed deceased
- Thousands of building demolitions
- \$30 billion rebuild



Tree Damage was Inevitable

- Short-term damage

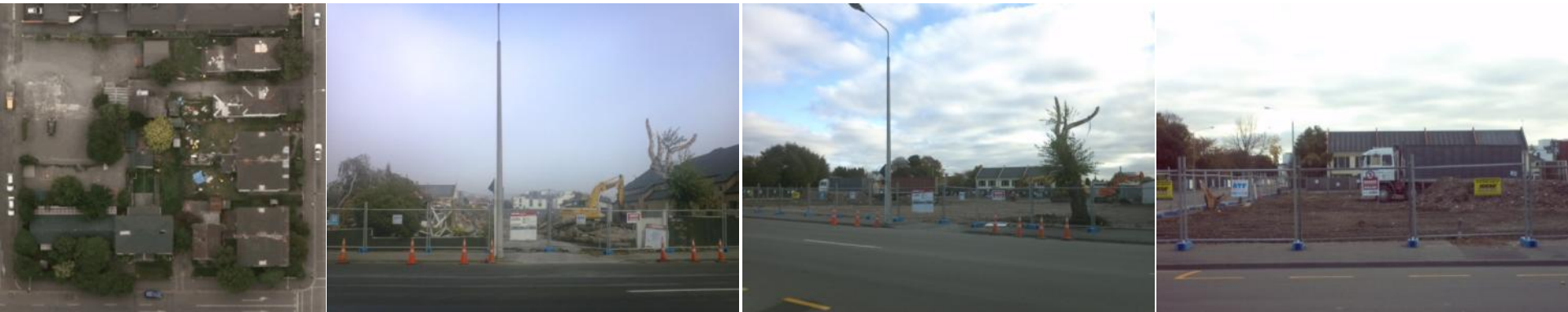
- Stem snapping
- Limb snapping
- Root damage
 - Lean
- Tipups



- 100+ year old oaks were “*not just shaking or trembling...but were violently moving from side to side in unison*”

Short-term Tree Damage

- 384 trees removed from public land in the short term
 - How many more have been/will be removed from private property?



- As demolition proceeds, so too does tree damage

Symptoms for Tree Removal

- Challenging decisions for city arborists
- Which trees should be removed?

Symptom Identified as Justification for Tree Removal	% of Total Trees Removed Exhibiting Symptom
Tree Lean	64.74
Soil Liquefaction	38.42
Soil Cracking	49.47

- Solutions need to be rapid and easily applied

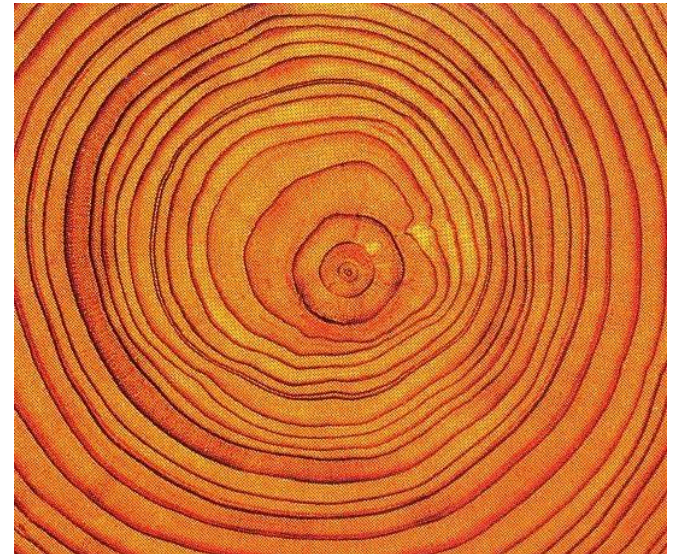
Rapid Assessment

- All public trees visually assessed after aftershocks greater than 5
- Assessments undertaken by numerous teams, so simple, repeatable tests necessary
- Rules of thumb based on Mattheck's windthrow equations



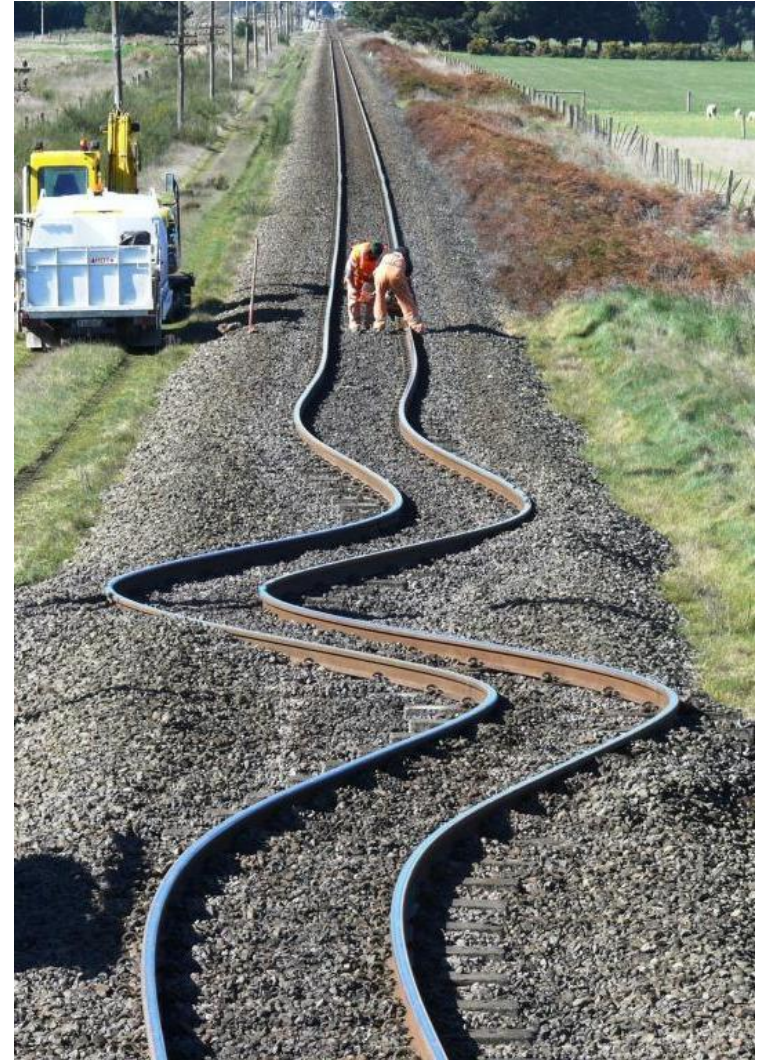
Long-term Tree Damage

- Dendrochronological records show different responses to historic earthquakes
 - Change is inevitable
 - Not necessarily positive or negative
 - Species composition changes are likely
 - Dependent on resultant soil environment



Mass Soil Movement

- Horizontal shifting up to 5m
- Vertical uplift of 40cm in hills surrounding city
- Subsidence of 40cm in eastern suburbs



Impacts of Soil Mass Movement

- Relative shift in water table
- Affects plant water relations and root respiration



Soil Liquefaction

- Compaction
- Dewatering
 - Sand volcanoes
- Inversion of topsoil and subsoil

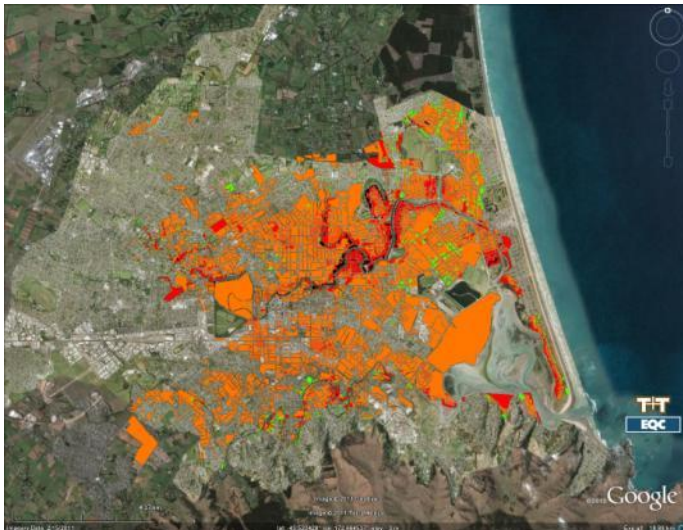


Impacts of Liquefaction

- Fine and medium sand subsoil up to 50cm deep is new rooting substrate
- Moderate water holding capacity
- No organic fraction
- Poor nutrient availability
- Hydrological discontinuity



Extent and Impact of Liquefaction



- Widespread, affecting ~ 4,000 hectares
- ~ 30,000 trees (public)
 - Tens of thousands more on private lands

Patterns of Tree Removals

- Spatially heterogeneous land damage
 - Uneven tree damage/removals
- Canopy cover, species, and age/size class distributions affected on local scale



Unexpected Benefits

- Trees protected houses and people from rockfall and landslides

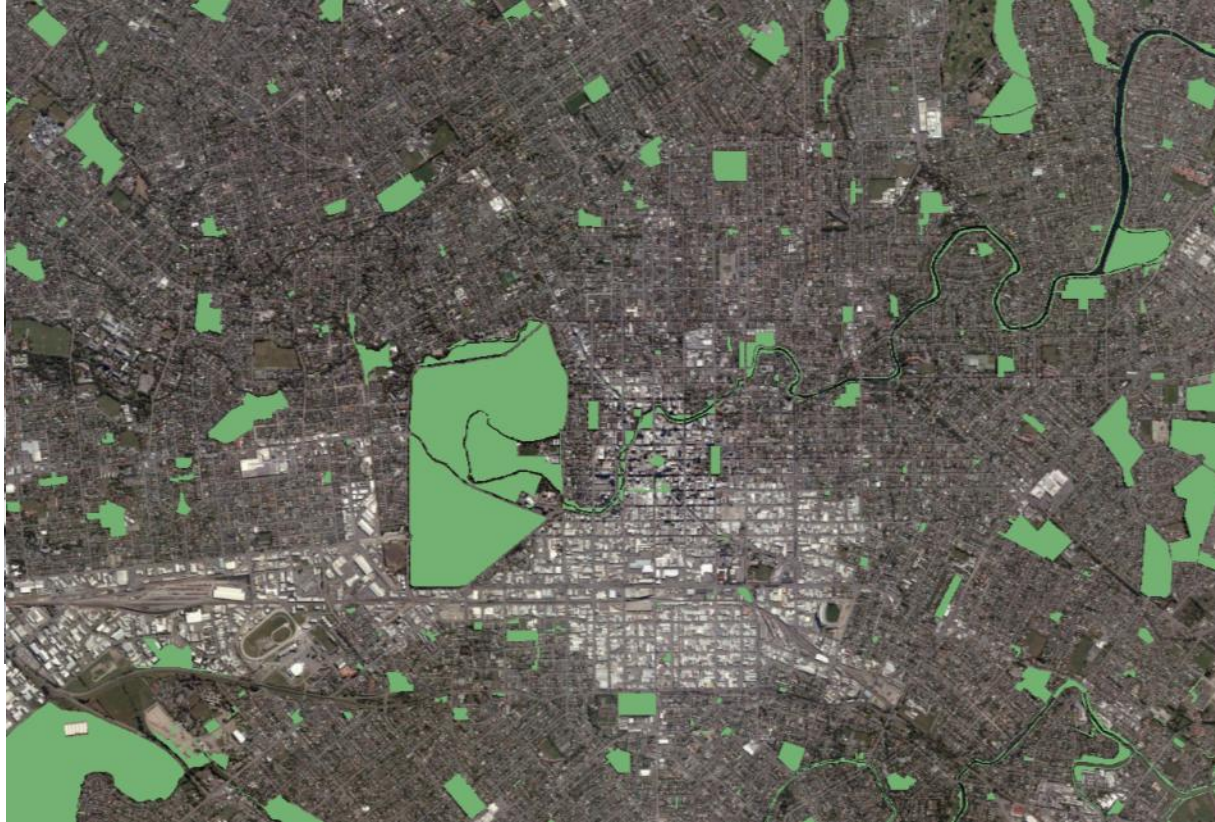


Trees and Rockfall Protection

- Shelterbelts protected houses and people from rockfall and landslides



Trees and Urban Resilience



- Refuge for displaced citizens
- Central meeting place for emergency services
- Importance of even spatial distribution of parks

Moving Forward

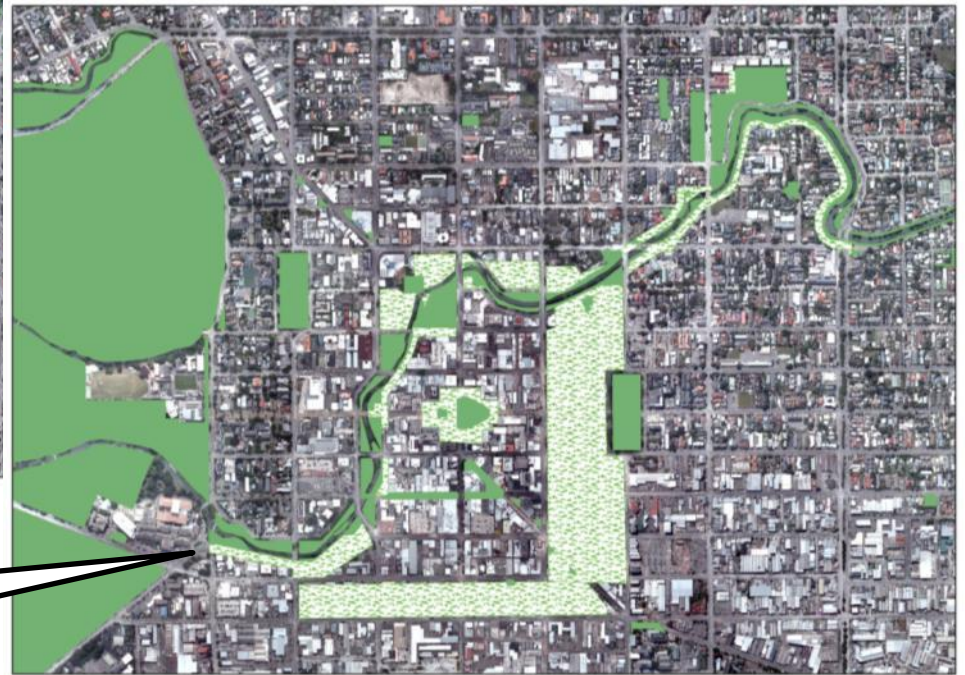
- Disaster or Opportunity?
 - 5,000 properties purchased
- Redevelopment at this scale is rare
- What has history taught us?
 - Land ownership is key
 - Hiroshima vs. Tokyo following WWII
 - Much will depend on gov't policy

The Central City Plan

Before...



106,000 public
submissions



40 hectare
'green' frame

...After

Lessons from a Resilient City

1. Immediate tree damage was minimal
2. There is a need for simple, repeatable, rapid tree stability tests
3. Long-term urban forest change is inevitable
4. Important role for trees and greenspace during disaster
5. Public desire, land ownership, gov't policy influence urban forest during redevelopment

Acknowledgements

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